625.8
B17c

[redacted]

[redacted] LIBRARY
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

I. O. BAKER

CONSTRUCTION · AND CARE · OF · BRICK PAVEMENTS

CENTRAL CIRCULATION BOOKSTACKS

The person charging this material is responsible for its renewal or its return to the library from which it was borrowed on or before the **Latest Date** stamped below. **You may be charged a minimum fee of $75.00 for each lost book.**

Theft, mutilation, and underlining of books are reasons for disciplinary action and may result in dismissal from the University.

TO RENEW CALL TELEPHONE CENTER, 333-8400

UNIVERSITY OF ILLINOIS LIBRARY AT URBANA-CHAMPAIGN

MAY 12 1999

MAY 12 1999

When renewing by phone, write new due date below previous due date. L162

STATE GEOLOGICAL SURVEY.

Governor C. S. Deneen, T. C. Chamberlin, E. J. James, Commissioners
H. Foster Bain, Director.

Construction and Care of Brick Pavements

BY

IRA O. BAKER

[From Bulletin No. 9, pp. 289-303.]

URBANA
University of Illinois
1908

The person charging this material is responsible for its return to the library from which it was withdrawn on or before the **Latest Date** stamped below.

Theft, mutilation, and underlining of books are reasons for disciplinary action and may result in dismissal from the University.

UNIVERSITY OF ILLINOIS LIBRARY AT URBANA-CHAMPAIGN

FEB 1 4 1977

FEB 1 4 REC'D

NOV 0 9 1987

FEB 0 6 1991

Mar 06 1991

12-13-91

DEC 0 6 1991

JUL 3 0 1993

JUL 0 7 1993

JUN 0 2 1996

L161—O-1096

STATE GEOLOGICAL SURVEY.

Governor C. S. Deneen, T. C. Chamberlin, E. J. James, Commissioners
H. Foster Bain, Director.

Construction and Care of Brick Pavements

BY

IRA O. BAKER

[From Bulletin No. 9, pp. 289-303.]

URBANA
University of Illinois
1908

Gift of Mrs. I. O. Baker to the Engineering Library Feb. 1926

625.8
B17c

mr 18 Je 26

CONSTRUCTION AND CARE OF BRICK PAVEMENTS.*

[By Ira O. Baker.]

Introduction.

It is not the purpose of this article to give a detailed description of the various operations connected with the construction of a brick pavement, since those having the direction of such operations are already familiar with the work or can easily find the information desired, but it is proposed to consider some fundamental relations whose importance seems to have been overlooked by writers on the subject as well as by those having the construction of brick pavements in charge. In short, this article is intended more for the property holder, the manufacturer, and the layman than for the professional engineer. The subjects to be considered will be taken up approximately in the order in which they occur in the work of construction.

Historical—A brick pavement consists of brick set on edge on a suitable foundation—either concrete, gravel, a course of brick flatwise, or a layer of plank. Such pavements have been used in Holland for perhaps a century, and to a much less extent and for a shorter period in northern England. Brick pavements were first used in the United States in 1870 at Charlestown, West Virginia, a place having a population of 12,000. The experiment was tried with a short section—less than a block—and in 1873 a block on the principal business street was laid with a good quality of building brick, and is still in service after 29 years. A block of brick pavement, laid in 1875 on a leading business street of Bloomington, Illinois, a place of 20,484 population in 1890, though constructed of an inferior building brick made of superior clay, continued in service for 20 years.

At present brick is the only paving material employed in most of the smaller cities of the Mississippi Valley, and it is used extensively in many of the larger cities in that territory. In all parts of this country, the use of brick for residence streets and light traffic business streets is rapidly increasing. A recent canvass shows about as much brick pavement in progress as granite block, asphalt, and wood com-

---

* Printed by permission in the Clay Record, October 30, 1906.

51854

bined. There are in this country nearly two hundred plants, devoted to the manufacture of paving brick, some having annual outputs of 60,000,000 to 100,000,000 bricks.

Width of pavement—In many cases a considerable part of the money spent for a pavement is wasted by making the pavement wider than is really necessary. A narrow pavement not only costs less to construct, but also costs less to clean and to sprinkle. Of course, except for the cost, the wider the pavement the better; but length is more desirable than width. An excessive width is a needless expense, and delays or wholly prevents the getting of any pavement at all; and hence one help towards securing pavements is to make them only wide enough to accommodate the travel.

It is not unusual to find residence streets in small cities, without street car tracks, with pavements 36 to 40 feet wide. The only travel over such streets consists of private carriages and the delivery wagons that supply goods of various kinds to the residents. All the pavement that such streets really require is a width such that two vehicles may pass at a reasonable speed and with ordinary care without interference. A width of 18 feet affords sufficient room for a vehicle to pass when another is standing on each side of the pavement—a rare occurrence;—and therefore it appears that a pavement 18 feet wide, or at most 20 feet, is sufficient for the less frequented residence streets. Therefore any money spent to construct a wider pavement is really not necessary; and the cost of sprinkling and sweeping is also needlessly increased. Further, narrowing the pavement increases the lawn space, which not only improves the appearance of the street, but also gives additional space in which to place gas pipes, water pipes, etc., and thereby prevents the tearing up of the pavement which is always a damage. The only objection to a very narrow pavement is the difficulty of turning a team on it. The seriousness of this objection depends upon the construction of the vehicle. Many delivery wagons, express wagons, etc., may be turned easily on an 18 foot pavement. If occasionally a vehicle is compelled to go to the corner to turn, or even to drive around the block, the inconvenience is not very serious, and it is so infrequent as not to justify any considerable expense to prevent it. If the block is long, or if the objection to some vehicles being compelled to drive around the block is considered important, then it is much cheaper to construct a turning place near the center of the block than to build an additional strip of pavement the entire length of the street.

The cost of a pavement, per square yard, is practically independent of its width, and therefore the reduction of the width of the pavement on residence streets from 36 or 40 feet to 18 or 20 feet will save nearly 50 per cent of the cost, and if the cost can be reduced one-half, the number of paved streets will be increased much more than proportionally.

It is not wise to take time to discuss the width of pavements on residence streets containing car tracks, nor on business streets; but a little investigation will show that in many cases the pavement is considerably wider than has been found entirely satisfactory under similar conditions. The views here express not mere theory, but are supported by experience in a number of cities. In recent years there has been a marked tendency, in the middle West at least, to reduce the width of pavements on residence streets and on business streets in the smaller cities. Attention is here called to the matter because far too often the width of the pavement is made a fixed proportion of the total width of the street regardless of the real needs of travel. This is only one of the many ways in which some municipalities suffer from the lack of more competent engineering service—the loss frequently being many times the supposed saving.

CONSTRUCTION OF SUBGRADE.

It is necessary to say that the subgrade is the ultimate support of any pavement, and that both the cost and the efficiency of a pavement depends upon the supporting power of the soil upon which it rests. There are only two ways of increasing or supplementing the supporting power of the subgrade: (1) by underdrainage, or (2) by constructing a pavement that will distribute the concentrated load of the wheel over a considerable area of the subgrade. Usually the former is both the cheaper and the more effective. Tile drainage is cheap to construct, is certain in action, and costs nothing for maintenance. With all soils, except clean dry sand, the cost of both the construction and the maintenance of the pavement can usually be materially decreased by proper underdrainage. Unless the subsoil is very open and porous, it is economical to lay a tile under each edge of the pavement, 2 or 3 feet below the surface of the subgrade.

Not only should the subgrade be properly drained, but it should be thoroughly rolled to compact the surface and also to reveal any soft spots. Usually just before a pavement is to be constructed, the street is dug up to lay sewers and water and gas pipes and to connect these with the private property; and almost universally the trenches are refilled in such a manner that great care and skill are required to construct a pavement which will not ultimately settle over the trenches, much to the damage of the pavement and the disfigurement of the street. It is always specified that the subgrade shall be thoroughly rolled; but it needs only a casual inspection of the pavements of any city to show that this is seldom in a manner to prevent settlement. The cheapest and surest method of preventing such settlement is to properly re-fill the trenches; but usually this is indifferently done, owing to the ignorance or the carelessness of the proper municipal officer, and as a consequence the remedy of this defect is left to the paving contractor.

The method to be employed in refilling trenches so that they will not settle, depends upon the kind of soil and also upon the relative cost of labor and water. The problem of the proper filling of trenches is too intricate to permit a thorough discussion here; but briefly it may be said that except in the case of comparatively clean sand and gravel, backfilling can be thoroughly done only by tamping; and to make this method successful it is necessary (1) that the material shall be moist enough to be plastic, but neither too wet nor too dry, (2) that it shall be deposited in layers not more than 3 or 4 inches thick and (3) that each layer shall be thoroughly tamped. To secure thorough tamping the relative number of tampers and shovelers is sometimes specified; but this alone is ineffectual since there is a natural tendency for the tampers to work less energetically than the shovelers, and besides more labor is required to tamp the soil around a pipe than higher up. No kind of municipal work should be more rigorously inspected than the filling of a trench over which a pavement is to be laid. The nearly universal result of a neglect in this respect is that a pavement built at great expense is disfigured or damaged by settlement, the repair of which will cost many times as much as it would have cost to properly fill the trench originally.

The subgrade should be rolled both longitudinally and transversely with a steam roller weighing not less than five tons. If the street is rolled in only one direction, only one set of trenches will be compacted. The subgrade can not be rolled transversely with a horse roller; and besides the horses' feet tear up the subgrade nearly as much as the roller compacts it, particularly when the rolling is almost completed. The roller should pass over the surface several times to settle the filling into the trenches and also to compact the surface by the kneading action of many passes of the roller. Unfortunately the specification requiring the use of a steam roller adds somewhat to the cost of a pavement, since that implement is expensive in first cost and also in maintenance; and since ordinarily it can be used only a comparatively short time each year; but its use is believed to be worth its cost, particularly if the trenches were not properly back-filled.

FOUNDATION.

Choice of Materials—There are several forms of foundation suitable for brick pavements, viz.: Concrete, gravel, macadam, a course of brick laid flatwise, or a layer of plank. Concrete is by far the most common foundation; and apparently a plank foundation was never used except in a single city, and it has been abandoned there.

It seems to be the common belief that only a 6-inch layer of concrete is a suitable foundation for a brick pavement. The truth is that in some cases a 6-inch layer of concrete is unnecessarily thick, while in other cases a layer of gravel or of broken stone will make an equally good and more economical foundation. Less skill is required with a gravel or broken stone foundation than with a concrete foundation. Those who have made cuts into concrete pavement foundations report that in many cases the concrete is no better than a layer of broken stone without cement, due apparently to carelessness, or inefficiency, or dishonesty in the construction. The process of placing gravel or broken stone is simpler, and therefore there is less danger of inferior work; and the gravel or broken stone requires less hand labor, which is an advantage to contractors in these days of inconsiderate demands of laboring men. As to whether concrete, gravel, or broken stone be used for the foundation in any particular case depends upon local prices and the local condition; and right here is where the city needs engineering advice of a high order, for a single word in the specification may add hundreds of dollars to the cost of the work without any return. It is more scientific and usually more profitable to give time to the consideration of the specifications beforehand than to the higgling with the contractor afterwards.

The various forms of foundations will be considered separately.

Concrete—Nowadays it seems to be the general belief that a 6-inch concret base is necessary for a brick pavement; at least, this foundation is used indiscriminately for business and residence streets, and is used indiscriminately also on the stiffest soil and on the softest. A 6-inch concrete foundation is ordinarily used under an asphalt pavement, which is a more or less flexible layer from 2 to 3½ inches thick; while the same thickness of concrete is ordinarily used with a brick pavement having a cement filler, which is a very rigid layer from 5 to 7 inches thick. Is there any evidence that the foundations of asphalt pavements are generally too weak?

An engineering journal recently contained an account of a test of the supporting power of an asphalt pavement, made by hauling over it a truck weighing 22,300 pounds and giving a pressure of slightly over three tons on two wheels having tires four inches wide. The foundation consisted of a 4-inch layer of natural-cement concrete mixed in the proportion of one part cement, two parts sand, and five parts crushed stone. The asphalt wearing surface was two inches thick. The subgrade consisted of "soft wet clay which has been much disturbed by many trenches for sewers and for water and gas pipes." The pavement had been in use twelve years when tested, and had shown no signs of failure. "The above load was hauled over this pavement from end to end and produced no effect upon the pavement except to make a slight depression in the asphalt where the wheels stood for half an hour, the day being warm."

Does this prove that the concrete foundation of brick pavements are generally needlessly thick? Surely if four inches of concrete over soft clay and under a 2-inch asphalt wearing-coat can support such loads, six inches of concrete is needless under brick pavement with cement filler.

Let us consider this question from another point of view. There are three and only three reasons for constructing a pavement, viz.: (1) To secure a smooth surface for ease of cleaning and to decrease tractive resistance; (2) to secure an impervious roof to prevent rain-water from softening the subgrade; and (3) to interpose a layer that shall distribute the concentrated load of the wheel over so great an area of the subgrade that it can safely support the load without depression. For the moment, we are not concerned about the smoothness of the surface, and hence nothing will be said here about the first reason for constructing a pavement. The wearing surface of a brick pavement is practically impervious whether sand or cement filler be used, and consequently a concrete foundation is not necessary to secure a water-tight roof to protect the subgrade. Therefore, the concrete foundation of a brick pavement acts only to distribute the load of the wheel over the subgrade. The concrete distributes the load by virtue of its ability to act as a beam; and this property is due to the cement which the concrete contains. If there were no cement in the concrete, the layer of gravel or crushed stone would distribute the concentrated load of the wheel over a considerable area. The pressure of the wheel is transmitted downward in diverging lines; and if the point of contact of the wheel is considered as the apex of a cone having its base on the subgrade, it may be assumed that the load of the wheel distributed nearly uniformly over the base of this cone. It is unwise to attempt here to go into the mathematics of the subject further, but the efficiency of a layer of broken stone in distributing a concentrated load is proved by the fact, that, under favorable circumstances as to soil and drainage, 4 inches of broken stone has successfully carried considerable travel, while 6 inch macadam roads are quite common in a number of states. If 4 or 6 inches of macadam without any other pavement will carry travel, the same thickness will certainly make a good foundation for a brick pavement under ordinary conditions—particularly if a cement filler is used, since the filler gives the course of brick a considerable transverse strength, as will be discussed later. The writer recently saw a piece of brick pavement with sand filler which is laid directly upon the black loam of the Illinois corn belt, which for six or eight years has carried the heaviest travel of a city of three or four thousand inhabitants, and which is still in good condition. A tile drain was laid at each side of the street, the subgrade was well rolled, and the paving bricks (not blocks) were laid upon a layer of sand and small gravel only one or two inches thick. Probably no small part of the success of this pavement is due to the fact that a prominent intelligent and successful local business man acted as inspector. The writer does not advocate the general adoption of this form of construction; but cites this case to show what can be done by intelligence and care, and to prove that a layer of concrete is not always necessary. A needlessly expensive form of construction is not only money wasted, but deters the construction of other pvaements.

Not infrequently pavements having a concrete foundation are found which have settled over trenches. Does not this prove that the ordinary concrete foundation is not strong enough? No, it simply proves that the foundation over the trench was not strong enough. There are two remedies for this condition of affairs. Either consolidate the filing in the trench better by rolling or tamping as described above, or make the concrete thicker over the trench. The first is cheaper and more scientific. In no case is it justifiable to thicken or strengthen the foundation over the entire street simply because trenches occupying from 5 to 10 per cent of its surface may not have been properly back-filled.

Before considering substitutes for concrete foundations, let us examine the concrete a little further. Formerly it was the custom to use a rich natural-cement concrete, because it was cheaper than a Portland-cement concrete of equal strength. A few years ago nearly all the Portland cement used in the country was imported, while now nearly all of it is of domestic manufacture; and further, it is not only home-made, but is both better and cheaper. Although natural cement is marvelously cheap, a concrete of a given strength can be made cheaper of Portland than of natural cement. Experiments made at the University of Illinois show that a concrete composed of one part cement, eight parts of coarse sand or fine gravel, and eight parts of screened or broken stone was considerably stronger in compression and also in bending than a concrete composed of one part natural cement, three parts of the same sand, and three parts of the same broken stone. These proportions have been practically tested in the construction of half a mile of pavement with the greatest satisfaction to all parties concered. Prices vary greatly with the locality, but in most, if not all, cases Portland-cement concrete is cheaper in proportion to strength than that made with natural cement.

Before dropping the subject of concrete foundations, a few words should be said in condemnation of the quite general practice of leaving the upper face of the concrete needlessly rough and irregular, with loose stones strewn over the surface. To secure a uniform surface for the pavement, the cushion coat should be of uniform thickness, and hence the top face of the concrete should be practically parallel with the surface of the finished pavement. Also any loose stones on top of the concrete causes the brick to be broken during the rolling and produces inequalities in the surface of the finished pavement. Both of these effects can be eliminated without appreciable expense by a little care.

Gravel—Where gravel is cheap, it is better to use a thicker layer of gravel without cement than a 6 inch layer of gravel with cement, *i. e.*, a 6 inch layer of concrete. To secure a good foundation, the gravel must be properly used, which apparently is seldom or never done. The usual method seems to be to dump the gravel upon the subgrade directly from wagons, and then to level off between the piles with shovels. By this process the lower part of the original piles is much more compact than the space between the piles; and rolling does not materially lessen the inequalities, since the roller, being a cylinder of considerable length, rides upon the tops of the piles and does not compress the gravel between them. The result is that soon after the pavement is completed, the natural settlement of the gravel foundation causes the surface to be full of depressions.

The better and cheaper method is to level off the piles with a scraping road-grader, (the ordinary "road machine") and then thoroughly harrow the gravel with a long-toothed harrow, after which the foundation should be rolled. For the best results, the gravel should be spread in layers not more than three or four inches thick. Brick pavements upon gravel foundations laid by this method have shown no depressions after many years, while those constructed with the utmost care by the preceding method with the same gravel on the same soil have been full of holes. This is another example showing that cheaper materials and proper methods intelligently give better results than expensive materials improperly used.

Broken-stone—Where broken stone is cheap, it is better economy to use more stone and omit the cement from the foundation, i. e., use broken stone alone instead of concrete. If the rock is soft or contains much fine material as it comes from the crusher, it should be screened to take out all dust and most of the pieces up to say ¼ inch in greatest dimensions. The broken stone may be hauled to the street in wagons, and dumped upon the subgrade. It may be spread by hand with forks or rakes, or it may be spread with a scraping road-grader, the latter method being the cheaper. In spreading the stone care should be taken that the several sizes are not separated too much, and that the piles on which the stone was dumped from the wagons are not left too high. The layer of stone should be rolled until the individual stones do not move as one walks over the surface, or until the surface stones are not easily kicked out with the foot. After the completion of the rolling, the surface of the broken stone should be impervious to the sand to be used in the cushion coat. With most stone this condition will be secured by the crushing of the top layer of the broken stone during the rolling; but if there are spots that are porous, throw on a few shovelfuls of fine stone and roll again. If the stone is hard, it may be necessary after the rolling is nearly completed to apply a thin coat of finer or softer stone. Of course the top of the foundation should finally be left smooth and of proper grade and crown.

The rolling required with either a gravel or broken-stone foundation can best be done with a steam roller, which is only an additional reason for specifying that the subgrade shall be rolled with a steam roller. Although it is a little out of place here, this is the most convenient place to say that a steam roller is also much better than a horse roller for rolling the brick. If the subgrade, and the gravel or broken-stone foundation, and the brick are all rolled with a steam roller, the cost of rolling any one of these is materially lessened, since the roller is thus used a greater part of the time.

Brick—The first brick pavements were laid on a foundation consisting of a layer of gravel and a course of brick laid flatwise. This form of foundation has been abandoned for two reasons: first, because some other form is usually cheaper; and second, because of the lack in the past of proper precautions in laying this form of foundation. There have been two defects in constructing this form of foundation. First, the gravel is neither spread nor consolidated uniformly. The proper method of spreading and rolling the gravel has been described above under the head Gravel. The second defect consists in laying broken bricks with their broadest side up, and hence the space below is not well filled while the cushion coat is being spread, and consequently after the pavement is completed the cushion coat works into these cavities and permits the surface of the pavement to sink. If all broken brick are laid on the broad side and care be taken thoroughly to fill the joints while laying the cushion coat, this form of foundation will give satisfaction, even though the lower course of brick be quite inferior. The writer is quite familiar with a piece of such pavement laid on a very unfavorable subgrade, but with proper precautions in the two respects mentioned above, which for ten or fifteen years has given entire satisfaction and has as good a surface as adjoining pavements on a concrete base, even though the latter are on a more favorable subgrade and carry less travel. This pavement illustrates a rule of construction that can not be repeated too often, viz.: No good brick pavement can be constructed without proper attention to all details.

CUSHION.

The cushion is a layer of sand 1 to 2 inches thick between the foundation and the wearing course of brick, to secure a uniform bed or bearing for the brick. Unless the bricks or blocks are unusually uniform, the cushion layer should be 2 inches thick.

The thickness should be as uniform as possible so that the bricks will settle evenly during the rolling; and therefore the top of the concrete foundation should be carefully finished with a surface parallel to the surface of the pavement. Not infrequently loose fragments of stone are left on the surface of the concrete, a result which is very undesirable, since they necessitate a thicker cushion and at best prevent the bricks from coming to a uniform bearing. With good workmanship in laying the concrete, there will be no loose pieces of stone on the surface; and if they do happen to get there, they should be removed before laying the cushion coat.

When the sand cushion is laid on a foundation of broken stone, care must be taken to roll the stone so that the jar of the traffic will not cause the sand to work into the broken stone, thus permitting the pavement to settle and to become rough and uneven. If the broken stone is rolled until the surface of the layer is firm and solid and does not shake under the foot in walking over it, unless the stone is very hard and tough there is not much danger of the sand's sifting into the stone.

The sand for the cushion should preferably be so fine as to be of a soft, velvety nature, and should contain no pebbles of any considerable size, or loam or vegetable matter. The size of pebbles permissible depends upon the thickness of the sand bed. Pebbles will prevent the brick from having a uniform bearing; the loam is likely to be washed to the bottom of the layer and cause the brick to settle; while the vegetable matter will decay or wash away, and leave the brick unsupported.

The spreading of the sand should be carefully done, so as to secure a uniform thickness and to have its upper surface exactly parallel to the top of the finished pavement. After the sand has been distributed approximately to the proper thickness with a shovel, the surface should be leveled by drawing over it a template conforming exactly to the curvature of the cross-section of the proposed surface of the pavement. The template should be drawn slowly over the sand bed several times, any depressions that develop being filled by sprinkling sand into them with a shovel. A considerable quantity of sand should be drawn along in front of the template, as this aids materially in packing the bed. It is necessary to draw the template several times to pack the sand well, particularly if there are wet and dry spots, as the successive jarring of the sand grains causes them to settle more closely together. When the sand cushion is properly packed it will have a uniform, smooth, velvety appearance, and will not look rough, porous and grainy.

The surface of the cushion layer is often prepared with a short lute; but the template secures a more uniform surface and also gives a greater compression and more even bed. With hand luting the surface of the pavement is almost certain to be covered with saucer-like depressions after it has been rolled. Hand luting should be prohibited except where the use of the template is impossible, as around man-hole covers, at street intersections, etc.

THE BRICK.

Character—A paving brick is simply a brick which, owing to careful selection of the clay and to skill in the manufacture, is so hard and tough that it will resist the crushing and the abrading action of the traffic. The brick should be reasonably perfect in shape, should be free from marked warping or distortion, and should also be uniform in size, so as to fit closely together and make a smooth pavement. Any particular brick should be homogeneous in texture and should be free from lamination or seams, so as to wear uniformly; and all the brick used in a pavement should be of the same grade so that the pavement may wear evenly.

Testing—To determine the difference in quality of bricks of different manufacture, it is necessary to carefully test them. This is done by rolling the bricks or blocks with blocks of cast-iron in a revolving cast-iron cylinder or "rattler." The National Brick Manufacturer's Association, as a result of an extended series of experiments, has adopted a standard method of conducting this test which is so well known or so easily obtained as to make it unwise to give the details here.

Different bricks are rated according to the loss by wear in the "rattler;" but the per cent of loss will depend upon the care employed in culling the brick and in selecting the samples, as well as upon the character of the brick. To show the results that may be expected, the following data obtained by a city in Illinois in the ordinary course of business are given. The samples were selected after delivery upon the the street, by a representative of the city. The tests were carefully made according to the "N. B. M. A. standard" as above. The material was in the form of books approximately 3″ x ″ 9″. The average loss of ten lots was 18.34 per cent with a range from 15.4 to 24.6 per cent; and omitting the largest result, the average was 17.64 per cent with a range from 15.4 to 21.2 per cent. Of the ten kinds of blocks, two had losses of less than 16 per cent, four less than 18, six less than 19, and eight less than 20 per cent.

The above data are for blocks approximately 3″ x 4″ x 9″. Bricks approximately 2″ x 4″ x 8″ will lose from 2 to 6 per cent more than the above blocks; but not enough data have been accumulated to determine with any accuracy the effect of size upon the loss in the rattler test.

A study of the details of the experiments referred to above indicates that an occasional manufacturer can furnish paving blocks giving a loss of 15 per cent or even less; but whether it is wise so to specify will depend upon the service required and upon the cost of different grades of paving blocks. A severe specification will require more careful culling of the product of the kiln and will also limit competition—both of which demands will increase the cost. The limit to be specified in any particular case will depend upon the special conditions; and should be the result of very careful study of the attendant conditions.

Setting the Brick—There is neither space nor need of discussing this subject here, further than to say that each brick should be pressed or rather struck against the side and also the end of the bricks already in position.

Inspection—After the bricks have been set in position the pavement should be carefully inspected, and all very soft or very hard bricks should be removed so that the pavement may wear uniformly. A brick having only a small piece chipped from the corner or edge may be turned over.

ROLLING THE PAVEMENT

After all rejected brick have been removed and the pavement has been swept, it is ready for rolling, which should be done with a steam roller weighing from 3 to 6 tons. A very heavy roller is undesirable, at least in the beginning of the rolling, since the first passage of it tilts the brick to one side so much that it is nearly impossible to straighten them up again. The roller should not weigh more than six tons, and four is better. Unless the top faces of the bricks are brought to a plane, the pavement will be rough and noisy, and will lack durability. The bricks should be firmly settled into the sand bed so that traffic may not depress some of the brick, which will make the pavement rough and also make it wear needlessly fast.

The pavement should first be rolled longitudinally, beginning at the crown and working toward the gutter, taking care that each return trip of the roller covers exactly the same area as the preceding trip so that the second passage of the roller may neutralize any careening of the brick due to the first passage. Pavements that have been rolled only once or always in one direction are very much rougher and more noisy than when properly rolled. If a spot is skipped on the return passage of the roller, it can be detected by a casual inspection of by the noise of a passing vehicle. The first passage of the roller should be made at a slow speed, not faster than a slow walk, to prevent undue canting of the brick. After the pavement has been rolled longitudinally, roll it back and forth transversely, or at least in both directions at an angle of

45 degrees from curb to curb. The purpose of the rolling is to settle the bricks uniformly into the cushion layer or sand bed. The rolling should not be done with a horse roller, since the horse's feet disturb the position of the loose brick, and also it is impossible to roll the street transversely.

FILLING THE JOINTS.

The joints between the bricks or blocks should be filled to keep the brick in the proper position, to lessen the chipping of the edges of the brick, and to prevent water from penetrating to the cushion coat and to the foundation. Three forms of filler are in common use, viz.: Sand, tar and hydraulic cement.

Sand Filler—Sand was the first filler employed for brick pavements, and in the Middle West is even yet almost exclusively used. The sand should be fine and dry, and should be worked into the joints by sweeping it over the pavement, which also should be dry. Although the sand is nominally always swept into the joints, it is usually simply spread upon the surface and left to be worked in by traffic, which is undesirable since the joints are eventually filled with manure and street dirt. The sand can be swept into the joints effectively and economically with a revolving machine sweeper. The cost of sweeping the pavement preparatory to filling the joints and the filling of the joints, including the cost of sand, is usually about two cents per square yard.

The advantages of a sand filler are: 1. It is cheaper than any other form of filler. 2. The pavement may be thrown open to traffic as soon as the bricks are laid. 3. The pavement may be taken up easily and without breakage of the brick. 4. It is practically watertight, particularly after being in service a short time.

The disadvantages of a sand filler are: 1. It does not protect the edges of the brick from chipping. 2. It may be washed out on steep slopes. 3. It is removed from the top of the joints by the street sweeper.

Tar Filler—Tar is occasionally used as a filler for the joints of a brick pavement pavement. The grade ordinarily used is that known to the trade as No. 5 or No. 6 coal-tar distillate. The bricks should be dry, and the tar should be applied at a temperature of 300° to 320° Fahr. by being poured into the joints with a vessel very much like a sprinkling pot without the nose. The success or failure of the tar filling depends on the efficiency and care of the person in charge of heating the tar. If the tar be too hard, it pulverizes in very cold weather; if it be too soft, it runs and becomes sticky in very hot weather. The cost of a tar filler depends upon the locality and upon the closeness of the joints. Usually tar costs from 6 to 8 cents a gallon; and one gallon is generally sufficient for one square yard of pavement. The total cost of the filler varies from 10 to 12 cents per square yard of pavement.

Tar is superior to sand in that it makes a perfectly watertight joint; and it is superior to hydraulic-cement grout in that it is not so rigid and therefore makes a more quiet pavement. Tar costs more than sand, and does not protect the edges of the brick as well as hydraulic-cement grout.

The objections to tar are: 1. In summer it is likely to melt and run out of the joints; and in winter it is brittle and likely to chip out of the joints. 2. The heating of it makes unpleasant odors on the street.

Cement filler—The most common joint filler, other than sand, is a thin mortar composed either of neat Portland cement or of 1 part cement and 1 part fine sand, the latter proportions being the more common. The pavement should be copiously sprinkled immediately before the grout is applied. The sand and the cement should be mixed in batches say of not more than 40 to 50 pounds of each at one time, in a tight mortar box. The box for this purpose should be 3½ to 4 feet long, 27 to 30 inches wide, and 12 to 14 inches deep, and should have legs of different lengths, so that the mixture will readily flow to the lower edge of the box, which should be 8 to 10 inches above the pavement.

The sand and the cement should first be mixed dry; and when the dry mixture assumes an even and unbroken shade, water should be added in a sufficient quantity to form a grout of the consistency of thin cream. The grout should be removed from the box to the pavement with a scoop shovel, and not by overturning the box; since by the last process the sand, cement, and water are separated and are deposited on different portions of the pavement. While the box is being emptied the grout should be constantly stirred to prevent a separation of the sand from the cement; and after the grout has been applied to the pavement, it should be quickly swept into the joints with steel brooms. It is better that the joints should be only about half filled at the first application, since then there is a less depth of grout in the joints and consequently less liability of the separation of the sand, the cement, and the water.

To secure the best results, a mortar box should be provided for each 10 feet of width of the street, and the full width of the street should be filled at practically the same time. After the filling has been carried forward for 40 or 50 feet, the same space should be filled again in like manner, except that the mixture for the second filling should be slightly thicker than the first. The joints should be filled entirely to the top in the second application. After the joints have thus been filled, a half inch of fine sand should be spread over the entire surface of the pavement; and if the weather is very hot or dry, the sand should be sprinkled at intervals for two or three days, to insure that the cement does not lose by vaporation the water necessary for chemical combination in setting. Traffic should be kept off the pavement from 7 to 10 days, or at least until the cement has firmly set. If the cement filler is disturbed before it is fully set, it is practically no better than sand. If the cement filler is put in as described above and allowed to set firmly before being used, it will wear no faster than the best paving bricks and will prevent spalling and chipping of the bricks at the edges and corners.

The amount of grout required will vary with the openness of the joints, with the depth of the grooves, and also with the quantity of sand of the cushion coat that works up into the lower part of the joints, while the bricks are being rolled. With a grout mixed 1 to 1, a barrel of cement will usually fill from 25 to 40 square yards. The cost of mixing the grout in small quantities and applying it as above varies from 1 to 1¼ cents per square yard; and with ordinary re-pressed blocks and reasonable care in securing close joints, the cost of a 1 to 1 Portland-cement grout applied as described above will usually vary from 10 to 12 cents per square yard.

The advantage of the cement filler is that it protects the edges of the bricks from chipping, and thus adds to the durability of the pavement. When the joints are filled with sand or tar, the edges of the bricks chip off, the upper faces wear round, the pavement becomes rough, and the impact of the wheels in jolting over the surface tends to destroy the brick; while with a good cement filler, the edges do not chip, the whole surface of the pavement is a smooth mosiac over which the wheels roll without jolt or par, and consequently the life of the pavement is materially increased.

An objection to the cement filler is that it does not take up the expansion of the pavement due to increase of temperature, and that consequently the pavement is likely to rise from the foundation and give out a rumbling noise as vehicles go over it. This rumbling can be prevented by placing a tar-joint from ½ to 1 inch thick next to each curb. The compression of the tar allows the bricks to expand without lifting the pavement from its foundation. This tar-joint can be inserted by setting a 1 inch board next to the curb before laying the bricks, and then after the bricks are laid withdrawing it and filling the space with coal-tar distillate No. 5 or 6. The longitudinal expansion can be taken up either by filling three or four transverse joints with tar, each 25 or 30 feet, or by inserting a 1 inch tar-joint each 40 or 50 feet. These expansion joints will require a gallon of tar for each 5 or 6 square yards.

An alleged objection to the cement filler is that in making repairs it is difficult to remove the brick without breaking many, and it is difficult to clean brick so that they may be used again. This is really an advantage if it will in any degree prevent the tearing up of the pavement; and at best this objection ought not to have much weight against durable construction.

A third objection is that the street can not be used while the cement is setting. Often the cement is not allowed to set fully before throwing the street open to travel, and consequently the chief advantage of the rigid filler is lost.

MERITS OF BRICK PAVEMENTS.

Bricks as paving material have some attractive features.

1. They may be had in small units of practically uniform size. 2. They may be had in large or small quantities. 3. They may be laid rapidly without special expert labor. 4. When failing pipes or other causes necessitate the disturbance of the pavement, ordinary tools and intelligence can restore the original surface. 5. Brick pavements give a good foothold for horse. 6. They do no wear slippery. 7. They are adapted to all grades, being used upon grades of 10 to 15 per cent without serious accident or inconvenience. 8. They have low tractive resistance, particularly if the joints are filled with Portland cement grout. 9. They are not specially noisy when properly laid. 10. Brick pavements themselves yield little or no mud or dust. 11. They are easily cleaned. 12. If the joints are filled with sand, they are only slightly absorbent; and if filled with tar or cement, they are absolutely non-absorbent. 13. Brick pavements have a pleasing appearance. 14. They are very durable, particularly if the joints are filled with Portland cement. 15. They are easily repaired.

Photomount
Pamphlet
Binder
Gaylord Bros.
Makers
Syracuse, N. Y.
PAT. JAN 21, 1908

UNIVERSITY OF ILLINOIS-URBANA

3 0112 000658796